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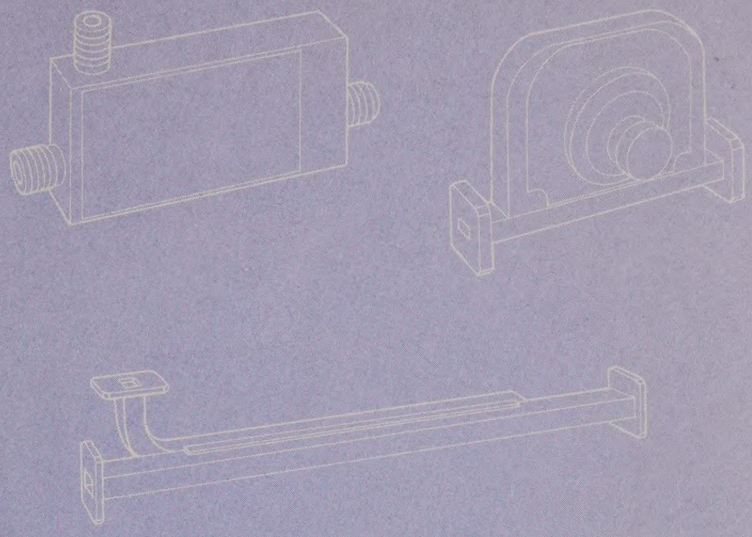

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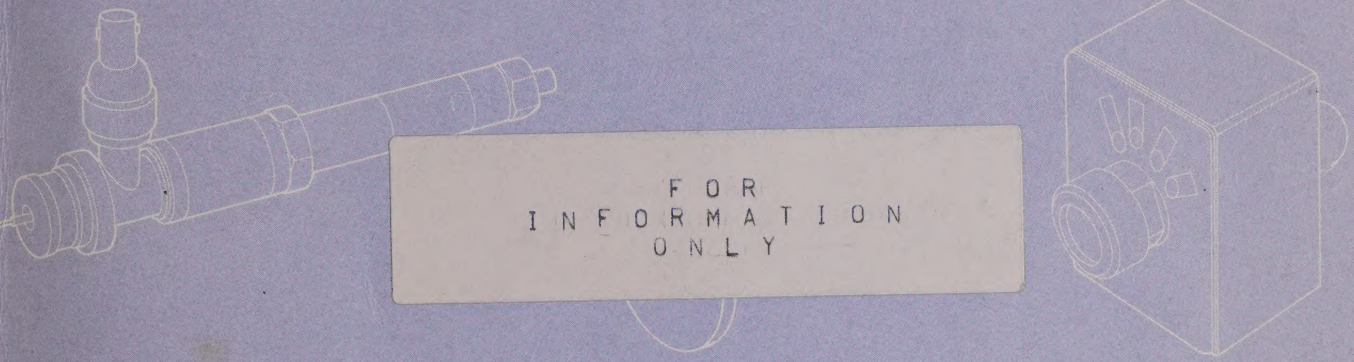
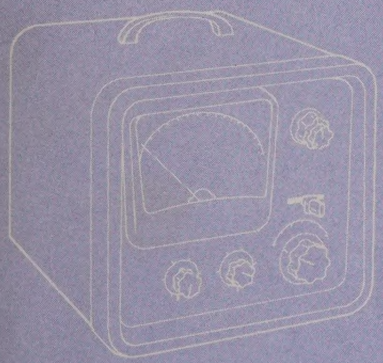
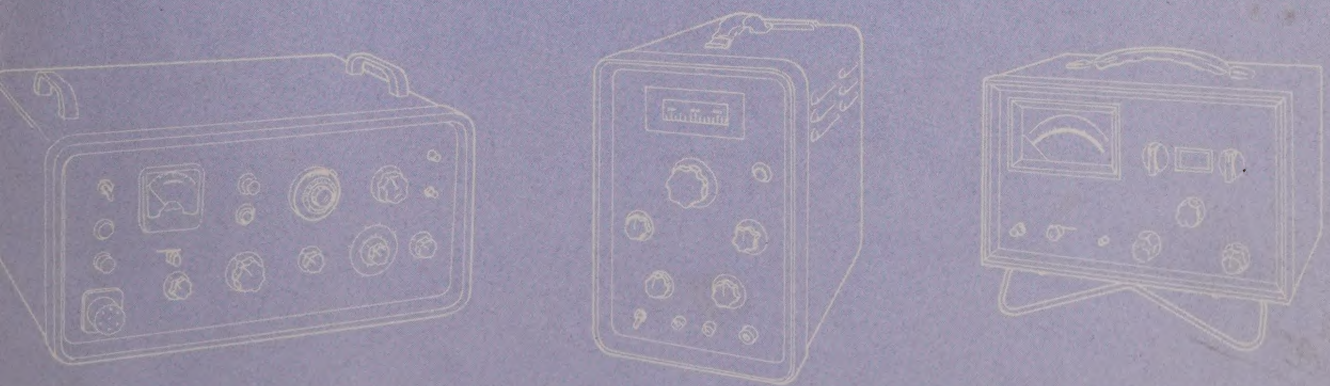




INSTRUCTION MANUAL

STANDING WAVE RATIO METER
NARDA MICROWAVE MODEL 441-C



microwave and uhf electronic test equipment

INSTRUCTION MANUAL

STANDING WAVE RATIO METER
NARDA MICROWAVE MODEL 441-C

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NARDA MANUAL CHANGES

ADDENDUM (NARDA Model 441-C)
Serial Number 01001 and Up

Change No.	New Data	Page
1	R14, Resistor 5.6K ohms, 1/2 watt plus/minus 5%	20
3	R88, R89 - Resistor, 4190 ohms 1/8 watt plus/minus 1/2%	22
2	R68, Resistor, 6630 ohms, 1/8 watt plus/minus 1/2%	22
4	CR3, which is part of T2 power transformer assembly should read CR7	schematic sheet 1
5	Battery pack installation instructions - battery is supplied with two leads (Red is positive and Black is negative). Solder these leads to terminal strip located on left side panel - (Red to Red and Black to White/Black).	15
6	CR3, Diode, Zener IN754A plus/minus 5% Motorola only (other mfg. selected at factory).	18
7	Q12 - Transistor, 2N1183 (selected at factory)	19
8	R12, Resistor 100 ohms	schematic sheet 1 of 2
9	R73, Resistor, Variable Wirewound IRC 110-100	20
10	R72, Resistor select at factory (100 ohms 1/2W, plus/minus 5% typical	schematic and p. 20
11	h. Normal-Expand Registration adjustment	12
	7. Repeat step f-11 and h-6 if necessary.	
12	Check point No. 7 on printed circuit board change to No. 5	schematic p. 2 of 2

Figure 1
Model 441 C
Standing Wave Ratio Meter

ADDENDUM (NARDA MODEL 441-C)

ADDITION	ADDENDUM	PAGE
1	VSWR MEASUREMENT PROCEDURE	14A
2	ATTENUATION MEASUREMENT PROCEDURE	14B

NOTE: APPLICATION INFORMATION

As in any other tuned amplifier as highly sensitive as the 441C, care must be taken when operating it in close proximity to other similar devices to prevent pick-up from extraneous radiations. This pertains only to the 50 and 60 scales at maximum gain and narrowest bandwidth.

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LIST OF ILLUSTRATIONS

Fig. 1 Model 441-C Standing Wave Ratio Meter

Fig. 2 Front Panel Operating Controls and Connectors

Fig. 3 Rear Panel Operating Controls and Connectors

Fig. 4 Functional Block Diagram

Fig. 5)
)
Fig. 6) Calibration Equipment Set-up
)
Fig. 7)

Fig. 8 Impedance Matching Pad

SECTION I DESCRIPTION

The 441-C basically is a high-gain tuned amplifier consisting of a regulated power supply, a low noise tuned amplifier, precision audio attenuators and a meter calibrated for use with a square law detector. For bolometer operation, the Model 441-C supplies the bias current to the bolometer element to bring the resistance to the correct operating point.

FEATURES of this instrument are:

1. Digital readout of attenuation in 2 db steps simplifies test measurements.
2. Front panel adjustments for 4.5 or 8.75 ma bolometers.
3. Frequency adjustable from 975 to 1025 cps.
4. Bandwidth continuously adjustable from 10 to 200 cps.
5. Meter reads state of battery charge and bolometer bias current for 4.5 and 8.75 ma bolometer.
6. Front panel switch for fast or slow meter response.
7. Detachable three conductor power cable for AC operation.

SECTION II — SPECIFICATIONS

GAIN

Less than 0.1 microvolt at 30 cps for full scale deflection on 60 db range over complete temperature range of 0°C to 55°C.

NOISE

With gain adjusted for 0.1 μv input for full scale:

(a) 7 db below full scale at 10 cps bandwidth
(b) 5 db below full scale at 30 cps bandwidth

FREQUENCY (Front panel knob)

1000 cps continuously adjustable from less than 975 cps to more than 1025 cps.
Stability - 0.0025%/°C.
(On special order any center frequency from 300-3000 cps.)

BANDWIDTH (Front panel knob)

Continuously adjustable from 10 cps (for highest sensitivity, lowest noise) to 200 cps (for sweep frequency testing).
Stability - ± 5% from 0°C to 55°C at 30 cps bandwidth.

INPUTS

Crystal, low and high current bolometers.

POWER REQUIREMENTS

115 or 230 volts AC, 50 to 500 cps 2 watts or (with optional, extra charge battery pack) completely portable DC operation free from power line disturbances and spurious grounds. Built-in recharger provides overnight recharge after 8 hours operation.

ACCURACY

Normal
± 0.1 db/10db step.
± 0.2 db maximum cumulative.

Normal - Expand
± 0.1 db when switching from any 10 db step (NORMAL) to any 2 db step (EXPAND), except ± 0.04 db when switching to 0.0 db (EXPAND).

Expand
± 0.02 db/2db step.
± 0.05 db maximum cumulative.

Meter Linearity
± 0.5% of full scale
(Less than ± 0.02 db on EXPAND DB scale)

SPECIFICATIONS (Cont'd.)

RANGE	2 db steps in EXPAND function 0 to 70 db in 2 db steps 10 db range on GAIN control 1 db range on FINE GAIN control
METER SCALES	VSWR NORMAL 1.0 to 4,3 to 10 VSWR EXPAND 1.0 to 1.25 MIRROR SCALE DB NORMAL 0 to 10 db DB EXPAND 0 to 2 db MIRROR SCALE 4.5 ma bolo bias, 8.75 ma bolo bias, battery voltage Meter response FAST or SLOW, front panel switch Automatic registration between scales
RECORDER OUTPUT	1 volt into 47 K ohms (minimum) at full scale deflection on all ranges Meter is still operating when recorder jack is in use
AC AMPLIFIER OUTPUT	0.1 volt RMS into 10 K ohms minimum

SECTION III — OPERATION CONTROLS

1. POWER SELECTOR — AC or BATTERY operation is determined by this switch. On CHARGE position the 441C is inoperative and the internal power supply charges the battery.

2. AC and CHARGE — Indicator lights when power switch is in AC or BATTERY CHARGE position.

3. INPUT — BNC connector for an input from the signal source.

4. INPUT SELECTOR
   8.75 and 4.5 BOLO — Provides current to a bolometer connected to the INPUT jack. Presents 2K ohm impedance to a crystal connected at the INPUT jack.

5. 10DB RANGE SWITCH — Provides 0 - 60db in 10db steps.

6. 2DB RANGE SWITCH — This control determines either NORMAL or EXPAND operation, and provides 0 - 8db in 2db steps.

GAIN CONTROL

7. Coarse — Provides a 10db variation of the overall gain of the 441C.

8. Fine — Provides a 1db variation.

9. BANDWIDTH — Provides for continuous adjustment of the bandwidth from 10 cps to 200 cps.

10. FREQUENCY — Adjustable from 975 to 1025 cps.

11. BATTERY-BOLO SWITCH
    Battery position — (Momentary Left) - Provides an observation on the panel meter of the relative battery voltage. The battery should be recharged when the relative battery voltage reads on or below the line indicated.

12. BOLO BIAS POSITION — (Momentary Right) - Indicates bolometer current directly on meter.

OPERATIONAL CONTROLS (Cont'd.)

13.	8.75 ma bias adj:	These pots provide independent adjustment of the 8.75 and 4.5 ma current ± 10%. This change is observed on the panel meter when the INPUT SELECTOR is in the 4.5 or 8.75 ma position.
14.	4.5 ma bias adj:	
15.	METER RESPONSE	Provides slow or fast meter movement.
16.	AC OUTPUT	Provides for the use of the 441C as a tuned amplifier. (This output is affected by BW control.)
17.	DC RECORDER OUTPUT	Supplies a DC output for recorder use.
18.	LINE VOLTAGE SWITCH	Provides for operation of the 441C on either 115 or 230 VAC line voltage.
19.	POWER	Connector for three - conductor AC power cord.
20.	FUSE HOLDER	Contains power line fuse, 1/32 ampere.
	CAUTION:	DO NOT OPERATE THE UNIT ON 230 VAC WITH THE SWITCH IN THE 115 VAC POSITION.

SECTION IV THEORY OF OPERATION

A. RANGE ATTENUATOR

The attenuator network consists of range switch S-104 with attenuation networks of 120 db. S-104A and B supply 80 db in 20 db steps. S-104 C and D, situated after the pre-amplifier section (A1-3), supplies 40 db in 20 db steps. Expand range attenuator, S-105 A and B, supplies 16 db in 4 steps. On EXPD 0 DB position, all 4 steps (16 db) are in the circuit.

B. PRE-AMPLIFIER

Transistors Q1, Q2, and Q3 comprise the pre-amplifier stage. After the signal goes through the first attenuation stage of 80 db, it is fed into the input stage Q1, amplified and fed into the remaining 40 db attenuator stage (S-104 C and D). This technique provides low noise performance where it is needed most. High ripple rejection is obtained by employing a double R-C network in the collector circuit of Q1 and Q2. R-18 sets the gain of the amplifier by varying the gain of Q3.

C. EXPAND CIRCUIT

The expand circuit provides a full scale meter deflection for a 2 db increment, while maintaining the original reference level. This is accomplished by applying a precise back bias current to the meter (M). On expand position, the gain is increased by taking out attenuation (R121-123) and a back bias is fed to the meter (M). This back bias provides for a 2 db full scale deflection.

D. TUNED AMPLIFIER

Transistors Q5 and Q6, along with R118 and C24, comprise the variable bandwidth, variable frequency, tuned amplifier. The normal operating frequency is 1000 cps; this frequency is adjustable over a $\pm$ 2.5% range by varying C24. The bandwidth adjustment, R118, varies the bandwidth of the unit from 10 to 200 cps. For normal operation, the bandwidth is 30 cps. The gain of the unit is controlled by coarse gain pot R-120 and fine gain pot R-119.

E. METER AMPLIFIER

Transistors Q7 through Q10 amplify the signal. The amplified signal is then rectified by the bridge rectifier diodes, CR1 and CR2. The rectified output from the bridge is indicated by the meter (M). The meter is calibrated for use with Square Law Detectors whose voltage output varies directly with input power.

THEORY OF OPERATION (Cont'd.)

F. BOLO BIAS SUPPLY

The bolo bias supply consists of transistor Q4 , S-102-B and associated resistors. Q4 determines the bias of the bolometer connected at the INPUT jack, J1. Q4 also serves as a bolometer burnout protection device, by limiting the voltage supplied to J1. Bolometer bias may be checked by setting S-102-B to Bolometer Check Position. The meter is calibrated to read bias current for 4.5 and 8.75 bolometers. The bias current may be accurately adjusted by varying R-83 for the 4.5 ma bolometer and R 86 for the 8.75 ma bolometer.

G. POWER SUPPLY

The power supply consists of the full wave rectifiers CR3 through CR6, control transistor Q11, and pass transistor Q12. With the INPUT SELECTOR switch on AC position, -18 volts DC is applied to the regulating circuit, Q11 and Q12. The regulated -12 volts DC can be measured on printed circuit board at the point marked -12V reg.

SECTION V BATTERY OPERATION

The Model 441-C may be operated from a battery instead of the 115 or 230 Volt AC supply. The rechargeable nickle-cadmium battery is factory installed if ordered as option A. (The same battery may be ordered and installed later. To obtain this, order Narda stock number 441-C 204. To install battery refer to Section VII.)

INITIAL BATTERY USE: When the 441-C is to be battery operated for the first time, set the POWER SELECTOR switch to CHARGE and allow the battery to charge for a minimum of 16 hours.

BATTERY ON: AC voltage to the instrument power supply is disconnected and the battery supplies all power. The pilot light is off. The Model 441-C chassis remains to the power line ground unless the power cord is removed. The battery supplies approximately 50 ma to the instrument and all circuits are DC regulated.

BATTERY CHARGE: Set POWER SELECTOR switch to CHARGE. AC power is supplied to the instrument and the pilot light is on. The Model 441-C is inoperative and approximately 40 ma DC charging current is supplied to the battery. The battery cannot be damaged by prolonged overcharging.

OPTIMUM BATTERY USEAGE: It is recommended that Model 441-C be operated on battery for up to 8 hours, followed by 16 hours of recharge.

AC OPERATION: When the 441-C is operated on AC, the pilot light is on. Approximately 7.5 ma DC "trickle charge" is applied to the battery.

SECTION VI MAINTENANCE and CALIBRATION

A. POWER REQUIREMENT

The Model 441-C may be operated from an AC source of 115 or 230 volts at 50 to 500 cps (power line frequency and the Model 441-C tuned amplifier frequency should not be harmonically related). With the instrument disconnected from the AC power, set the LINE VOLTAGE switch (located on the rear panel) to the desired position.

B. REMOVAL OF CHASSIS FROM CABINET

The chassis is held by four screws which are located on the rear panel. Simply remove these screws and slide the chassis out of the cabinet. Note: If unit is supplied with a battery, the battery access plate must be removed and the battery disconnected.

NOTE:

The Model 441-C is calibrated for use with Square Law Detectors such as bolometers and crystals. The output voltage of such detectors varies directly with input power. In any of the procedures and checks in section (VI) where the input is controlled by an external attenuator calibrated in decibals, the Model 441-C Meter will indicate 1 db change for each 2 db inserted in the input.

A 10 db change in the Model 441-C Range switch corresponds to a 20 db change in the input source attenuator.

REQUIRED EQUIPMENT ACCURACY

Calibration of this instrument, within the specifications, is not possible unless the accuracy of the test equipment is known. To check the tracking of both the RANGE and EXPAND attenuators, the attenuators used to perform these measurements must be calibrated and an error chart used.

Calibration must be known to an accuracy of ± 0.02 db for 1 db steps, to ± 0.03 db for first 10 db step, and to ± 0.07 db for succeeding 10 db steps (to a total of 60 db) for attenuator.

C. CALIBRATION PROCEDURE

a. INITIAL HOOK-UP

1. Set 10 db range switch to NORM position: 0 DB SCALE.
2. Connect 441-C, through a variac, to the AC line and set the variac to 115 V AC.
3. Set POWER SELECTOR to AC position.

b. POWER SUPPLY ADJUSTMENTS

1. Connect a H. P. 412-A or equivalent to - 12V REG. and to P. S. GROUND (located on P. C. B.)

2. Connect Ballantine 320 AC VTVM or equivalent to - 12V REG. and P. S. GROUND (for ripple check).

3. Adjust R-69 (on P. C. B.) for - 12 volts.

4. Alternately set variac to 105V AC and 125V AC and adjust line regulation pot R-59 until the ripple at 105V AC equals the ripple at 125V AC. Reset variac to 115V AC.

5. Recheck - 12 volts, re-adjust if necessary.

c. FREQUENCY CONTROL ADJUST

1. Set up equipment as shown in Fig. 6 in calibrate position.

2. Set audio oscillator output for 1027 cps.

3. Set 441-C RANGE scale at any convenient position.

4. With frequency control fully ccw, adjust C44 (accessible through housing on left side of the unit) for maximum indication on METER.

d. BANDWIDTH ADJUST

1. Set up equipment as shown in Fig. 7.

2. Set audio oscillator to 1 KC.

3. Peak 441-C to 1 KC by varying FREQUENCY control. Set BANDWIDTH control to 30 cps pointer.

4. Adjust Model 441-C GAIN controls to obtain a METER reading of 0 db at any convenient RANGE attenuator setting.

5. Vary audio oscillator in one direction until METER reads 1.5 db down from reference.

6. Vary audio oscillator in other direction until METER reads 1.5 db down from reference.

7. Difference between above two steps should be 30 cps.

8. To reset BANDWIDTH control to 30 cps, vary BANDWIDTH control and repeat steps 5 and 6 above until difference is 30 cps. With BANDWIDTH at 30 cps loosen BANDWIDTH control knob, and set knob to correspond to 30 cps marker on front panel. Then tighten knob SET SCREW.

e. GAIN ADJUSTMENT

1. Set up equipment as shown in Fig. 6.

2. Set 10 db RANGE switch to NORM position: 0 db scale.

3. Set COARSE and FINE GAIN control fully CW.

4. Set audio oscillator to 1 KC, with switch in set level position, adjust audio oscillator output for 0.1 volts* (full scale on AC VTVM).

5. Switch to calibrate position.

6. Adjust R-18 for full scale reading.

7. Check COARSE GAIN control for 10 db range minimum.

8. Check FINE GAIN control for 1 db range min. (with coarse gain control set for max. gain).

f. EXPAND LINEARITY CHECK

1. Set up equipment as shown in Fig. 7.

2. Set audio oscillator to 1 KC and adjust output for reading of 0 db on 546-C meter.

3. Set 1450 TBR for a minimum attenuation of 10 db.

4. Set COARSE and FINE GAIN controls to minimum.

5. Set BANDWIDTH control to 30 cps.

6. Set 10 db RANGE switch to 30, EXPD position.

7. Adjust audio oscillator output voltage for 0 db reading on Model 441-C METER.

8. Set 1450 TBR to read 14 db.

9. METER should read 2 db. Re-adjust R-74 (located on P.C.B.), 2 db expand adj. pot for a METER reading of 2 db, if necessary.

10. Reset 1450 to 10 db. Use FINE GAIN control to reset METER to 0.

11. Repeat steps 8 through 10 until EXPD scale is adjusted perfectly.

g. METER ACCURACY CHECK

With 1450 TBR set at points tabulated, METER should read the following:

Decade Attenuator		METER
1.0 db	=	.5 db
2.0 db	=	1.0 db
3.0 db	=	1.5 db
4.0 db	=	2.0 db

h. NORMAL EXPAND REGISTRATION ADJUSTMENT

1. Set up equipment as shown in Figure 7.

2. Set 10 db RANGE switch to 30 db NORM position.

3. Adjust signal for 0 db METER reading.

4. Set 2 db RANGE switch to 0 db EXPD.

5. Adjust R-73 for 0 DB reading on EXPAND scale.

6. Repeat steps 3 through 5 until the meter reads 0 DB on NORMAL scale and 0 DB on EXPAND scale.

i. 10 DB RANGE TRACKING

1. Set up equipment as shown in Figure 7.

2. Set audio oscillator frequency to 1KC, adjust output for reading of 0 db on 546-C meter.

3. Set 1450 TBR for a minimum attenuation of 10 db.

4. Set 441-C RANGE attenuator to 0 db EXPD position, BANDWIDTH to 30 cps, GAIN controls in maximum CW position.

5. Set 546-C multiplier switch to 100 db position and adjust output control for a reading of 1 db on the 441-C METER, on the 0 to 2 db EXPAND scale.

6. Switch 546-C microvolter by 20 db and the MODEL 441-C RANGE switch to 10 db. Record reading of the MODEL 441-C on the 0 to 2 db EXPAND scale.

7. Continue switching the 546-C microvolter in 20 db increments and increasing the 441-C RANGE switch in steps of 10 db until the 546-C microvolter reads 0 db and the 441-C RANGE switch reads 50 db.

8. Adjust 1450 TBR Decade Attenuator to read 30 db and increase the 441-C RANGE switch to read 60 db.

9. Subtract each MODEL 441-C METER reading from the previous reading. This tracking error should be within the specifications of ± 0.1 db for any 10 db step and ± 0.2 db maximum cumulative.

j. 2 DB EXPD TRACKING

1. Repeat steps (1) through (3) of paragraph (i).

2. Set 441-C RANGE attenuator to 30 db EXPD position. Set BANDWIDTH control to 30 cps, GAIN controls to maximum CCW position.

3. Adjust 546-C microvolter to obtain a reading of 1 db on the 441-C METER, on the 0 to 2 db EXPAND scale.

4. Increase the attenuation of the 1450 TBR by 4 db and the MODEL 441-C EXPD RANGE switch to 2 db. Record reading of the MODEL 441-C on the 0 to 2 DB EXPAND scale.

5. Continue increasing the attenuation of the 1450 TBR in steps of 4 db and the MODEL 441-C in steps of 2 db until the MODEL 441-C EXPD RANGE attenuator reads 8 DB.

6. Subtract each MODEL 441-C METER reading from the previous reading. This tracking error should be within the specifications of ± 0.02 db for any 2 db step and ± 0.05 db maximum cumulative.

* This 0.1 volt assumes a generator with a 200 ohm source impedance calibrated into a matched load.

D. TROUBLESHOOTING AIDS

Typical AC voltages, referenced to ground, on 0 DB NORMAL scale with a 30 cps bandwidth and full gain.

POINT	RMS VOLTAGE
Collector of Q7	16 millivolts
Junction of Q7 Collector and Q8 Base	3 millivolts
Q8 Collector	45 millivolts
Q10 Collector	1.7 volts
AC Amplifier Jack	45 millivolts

E. TEST EQUIPMENT REQUIRED FOR CALIBRATION

Variable AC Voltage Source (Variac)

H-P 412a DC VTVM or Equivalent

Ballantine 320 AC VTVM or Equivalent

H-P 200 cd or Equivalent

H-P 5512a Frequency Counter or Equivalent

GR-546-C Microvolter or Equivalent

GR-1450 TBR Decade Attenuator or Equivalent

Impedance Matching Pad

VSWR MEASUREMENT PROCEDURE

1. Turn Model 441-C power switch to AC (or battery, if used). No warmup time is required.

2. Set INPUT SELECTOR for type detector being used. Bolo (Bolometer) bias may be checked by moving Bolo Bias switch to extreme right.

3. Connect detector cable to INPUT.

4. Set RANGE switch to 40 db or 50 db NORM (normal) position. Adjust probe depth to obtain an on-scale reading. (It is recommended that probe depth be kept at a minimum. Deep probe depth causes errors in VSWR readings).

5. Peak Model 441-C (needle moves to right) by adjusting the modulation frequency of the signal source, if adjustable. Frequency peaking is also achieved by adjusting the FREQUENCY control knob located on the front panel of the MODEL 441-C.

6. Tune probe, if tuneable, to maximum output. Reduce probe depth to keep on-scale METER reading.

7. Move the probe along the line to obtain reading on the Model 441-C METER.

8. Adjust GAIN of Model 441-C and/or output power from the signal source to obtain a VSWR reading of exactly 1.0.

9. Move the probe along the line to obtain a voltage minimum (needle moves left).

10. If the indicated VSWR is between 1 and 1.25, greater accuracy is obtained if the Model 441-C EXPD (expand) function is utilized. For a VSWR between 1 and 1.25 a VSWR scale is provided when the RANGE switch is changed to EXPD position.

11. For a reading between 1 and 3 on the 1 to 4 VSWR scale, change RANGE switch to NORM position.

12. For a VSWR reading between 3 and 10 on the 3 to 10 VSWR scale, change the RANGE switch to the next 10db position above the initial setting.

ATTENUATION MEASUREMENT PROCEDURE

Because the Model 441-C METER provides a high resolution DB scale, the insertion attenuation in a line may be measured (within the accuracy of the detector). This same basic procedure may be used to check the accuracy of any variable attenuator. The procedure is outlined below.

1. With the attenuation to be measured out of the circuit, select an appropriate RANGE switch (dependent upon value of attenuation to be measured) in the NORM (normal) operating position.

2. Adjust the GAIN control for "0" db reference.

3. Insert the attenuation to be measured and change the RANGE switch to obtain an on-scale reading on the 0 to 10 db scale (for example, assume the Model 441-C was initially set on the 40 db scale and when the RANGE switch is changed to 50 db the Model 441-C indicates a reading of approximately 3 db.

4. Observe which 2 db segment the meter needle lies within (2 to 4 db for this example) and set EXPD (expand) switch to select this segment (set to 2 db). This expands the selected segment to a full scale presentation while automatically normalizing the selected starting point of the scale (2.0) to "0" on the db scale.

5. Read the indication on the 0 to 2 db EXPAND scale (for this example assume 1.3).

6. The total inserted attenuation = (RANGE switch setting) + (EXPD switch setting) + (METER reading on the 0 to 2 db EXPAND scale) - (initial RANGE switch setting). (For this example: 50 db + 2 db + 1.3 db - 40 db = 13.3 db)

SECTION VII BATTERY PACK INSTALLATION

To install battery, remove unit from housing. The rear panel is supplied with two bolts to secure battery. The battery is supplied with two leads (Red is positive and White is negative). Solder these leads to terminal strip located on left side panel - (Red to Red and White to White.)

CAUTION: IF FOR ANY REASON, THE BATTERY POLARITIES ARE REVERSED THE UNIT WILL BE DAMAGED.

SECTION VIII ADDITIONAL EQUIPMENT

The NARDA Microwave Corporation manufactures a line of complimentary equipment to be used with the MODEL 441-C. Refer to NARDA Catalog or your local NARDA Sales Representatives for complete information on the following microwave items:

A. BOLOMETERS

Used with a MODEL 441-C for square law detection, for VSWR and attenuation measurements. NARDA Bolometers recommended for use with MODEL 441-C:

For VSWR	N610-B
For Attenuation	N605, N610-B, N821-B, N603 (coaxial)

B. R.F. PROBE

Broadband probe covers microwave frequency range. The depth is variable.

C. SLOTTED LINE SECTIONS

Waveguide and Coaxial Impedance Meters are available for VSWR and impedance measurements from 1.12 to 90.0 Gc.

D. DETECTOR MOUNTS

A complete line of Waveguide and Coaxial Bolometer Mounts are available for attenuation measurements with the MODEL 441-C.

SECTION IX SHIPPING INSTRUCTIONS

Extra care must be taken to be certain that the unit is properly packed. Units shipped back for repair must be protected from transportation damage. If a unit arrives damaged, delay will be caused in determining who is liable. Whenever possible, the original shipping carton should be used. If this is not possible, wrap the instrument in heavy Kraft Paper or an equivalent material. Pack in a rigid container, which is at least four inches larger than the unit. Surround the unit with packed excelsior or similar shock absorbing material. Mark the container clearly for proper handling and insure adequately.

SECTION X PARTS LIST

Symbol	Description (NARDA Part No.)
A	Not assigned
BT-1	Optional Nickel Cadmium Battery (441C-204
C1, C9, C34, C35, C41	Capacitor 100 uf 15WVDC Sprague 89D-217
C3, C6, C10, C13, C18, C25, C29, C30, C33	Capacitor 4 uf 15WVDC Sprague 89D-155
C2, C7, C8, C12, C14, C19, C20, C21, C22, C26, C27, C28, C31, C32, C36, Thru C40	Capacitor 50 uf 15WVDC Sprague 89D-164
C5	Capacitor 200 uf 15WVDC Sprague 89D-219
C11	Capacitor 0.1 uf 200 WVDC Sprague "Pacer" Filmite "E" 192P-104-02
C15, C16, C17	Capacitor 0.1 uf 50WVDC Centralab CK-104
C23	Capacitor 2500 pf $\pm$ 2% 500WVDC (Crimpleads) Arco DM-19-252G
C24	Capacitor #PC 4612 Arco Electronics
C42	Capacitor 500 uf 25WVDC Cornell Dublilier BR-500-25
C43	Capacitor - Electrolytic 500 uf 50WVDC Sprague "Atoms" TVA 1315
CR1, CR2	Diode, Germanium IN34A (Sub-Miniature) Glass General Instrument
CR3	Diode, Zener in 754 A $\pm$ 5% Motorola, Texas Inst. or Int. Rect. Corp. only
DS-1	Lamp Dialco Part No. 38-1531 with legend "on"
F1	Fuse - 3AG 1/32 AMP SLOW BLOW

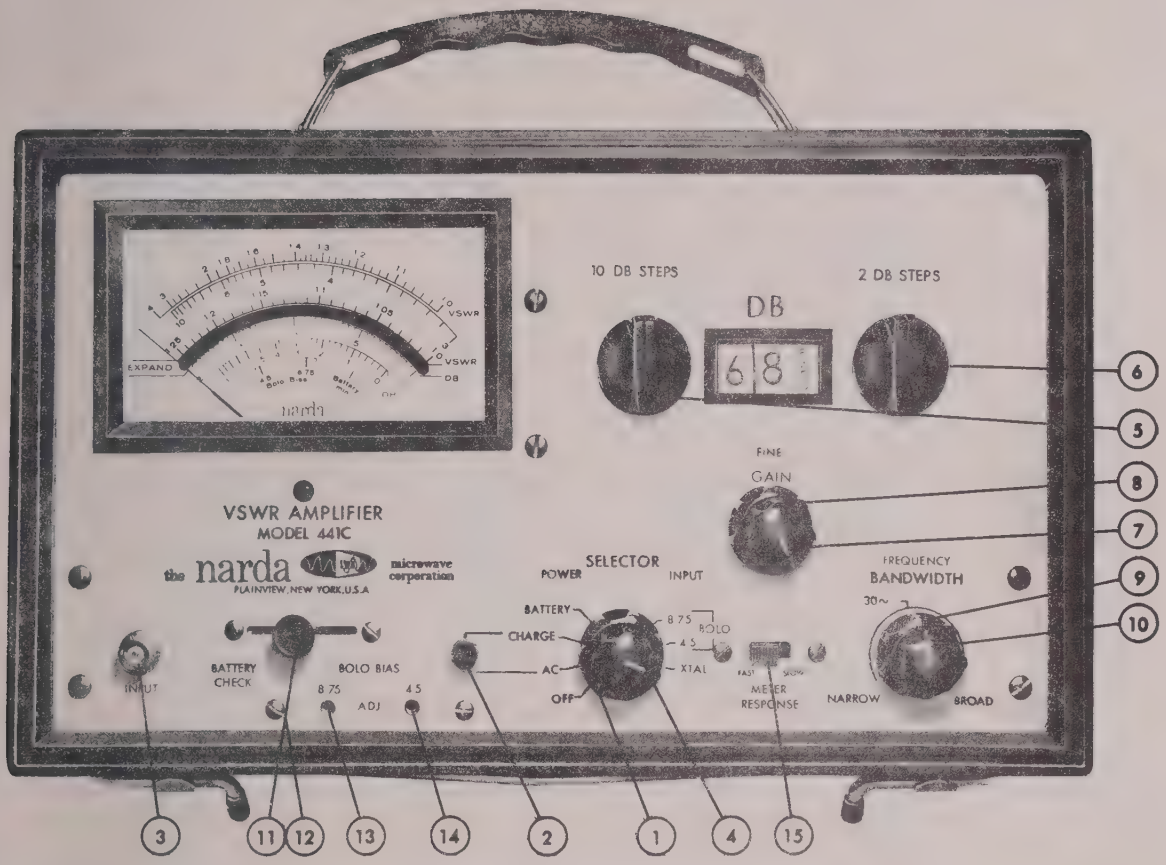


FIG. 2 FRONT PANEL OPERATING CONTROLS AND CONNECTOR

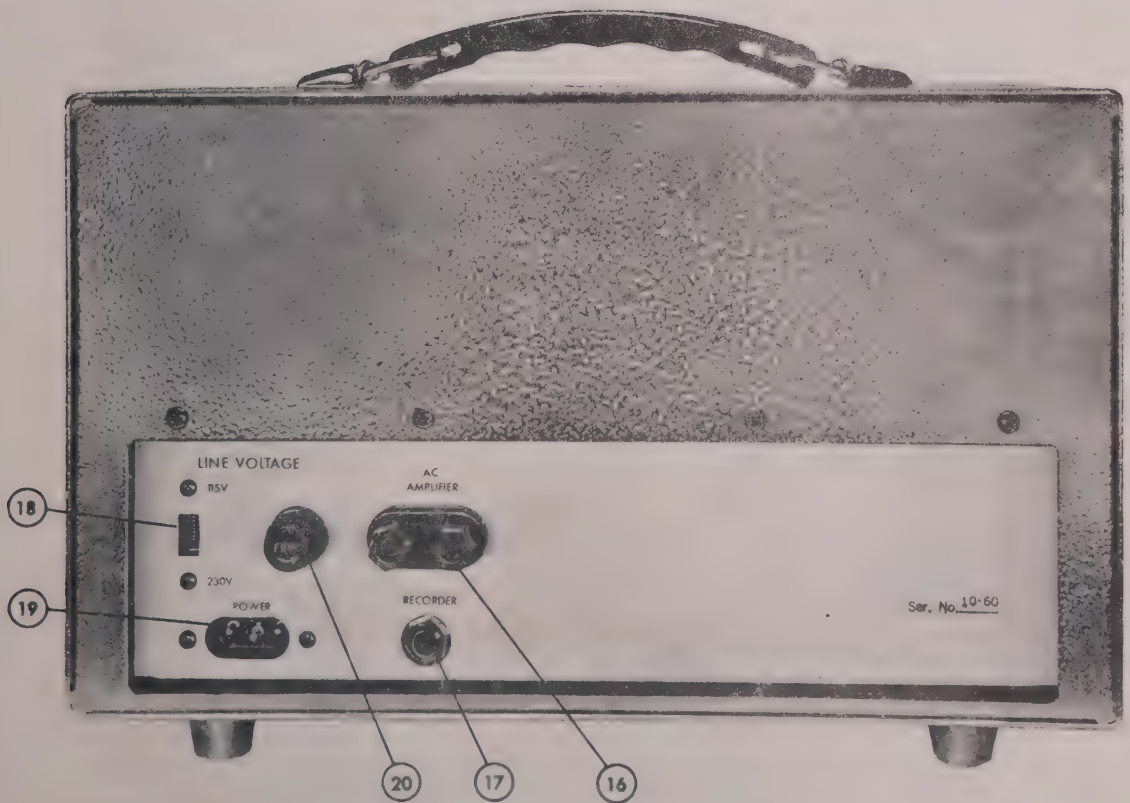
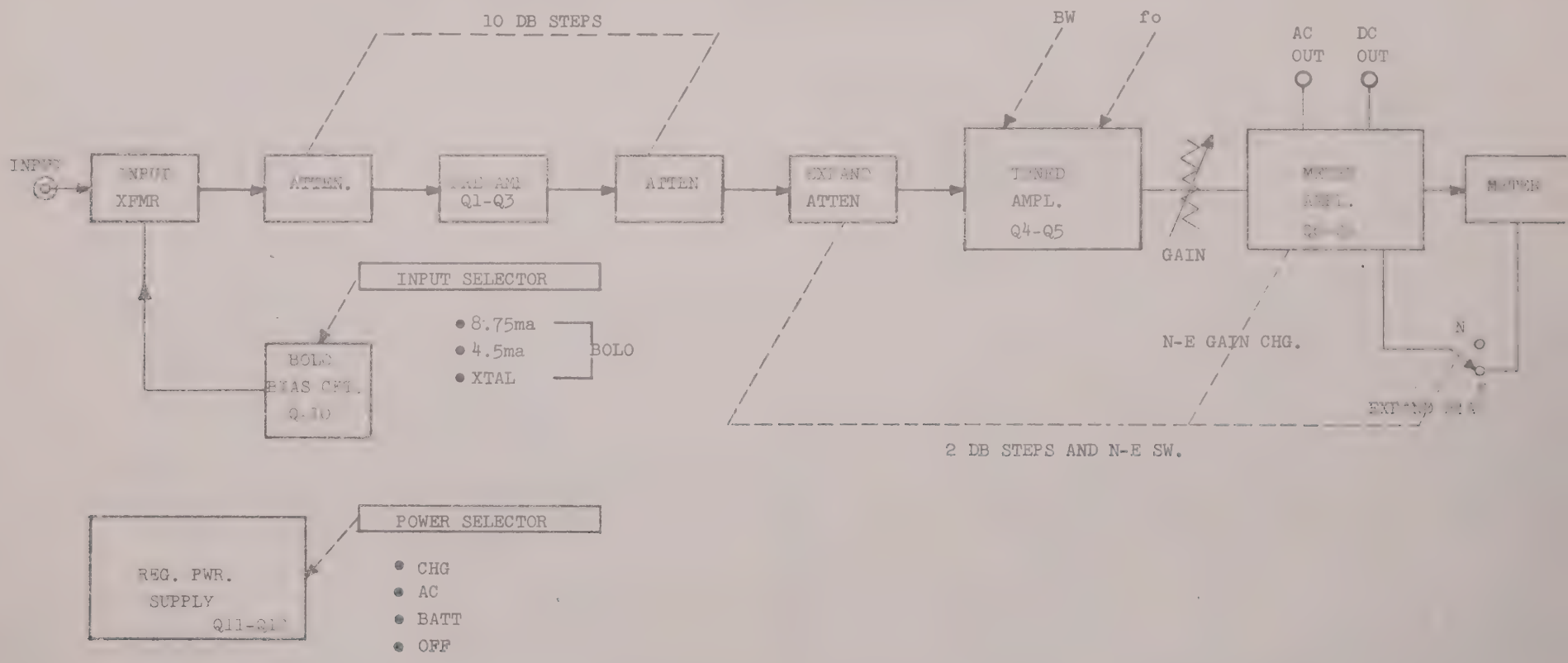


FIG.3 REAR PANEL OPERATING CONTROLS AND CONNECTORS



FUNCTIONAL BLOCK DIAGRAM

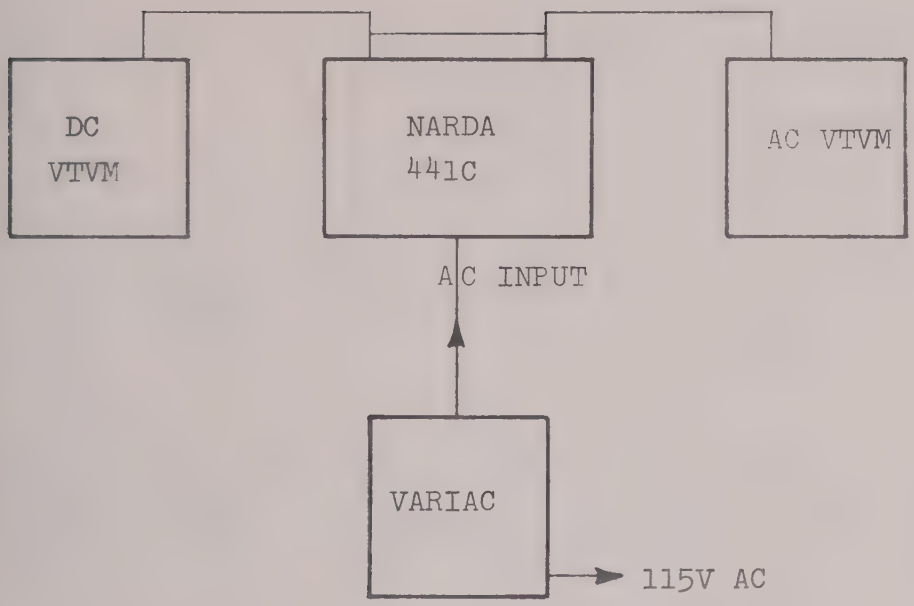
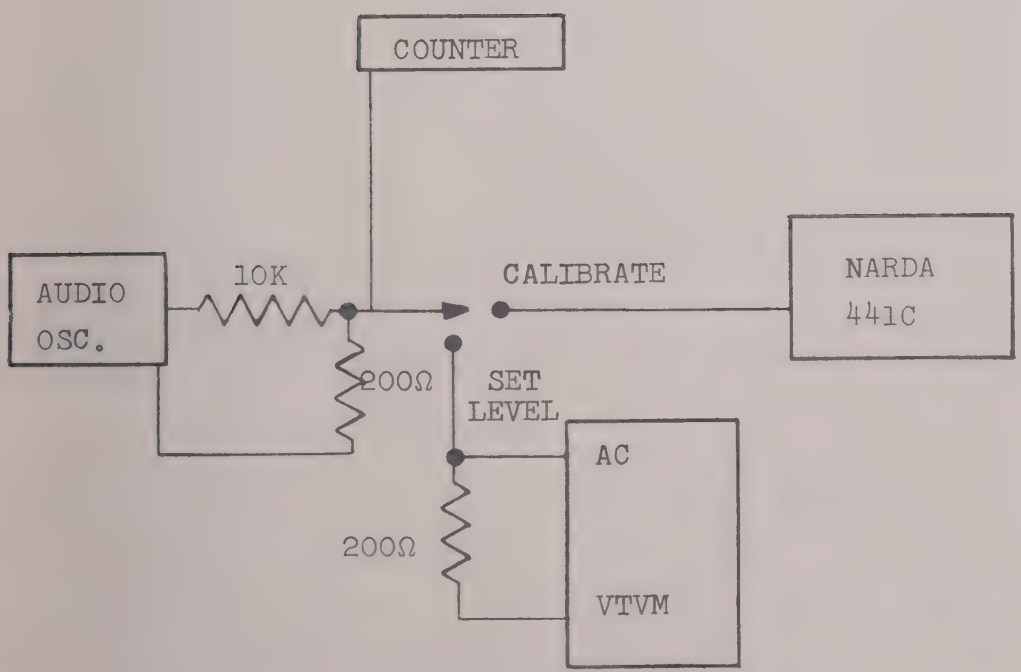


FIG. 5



ALL RESISTORS 1W 5%.

FIG. 6

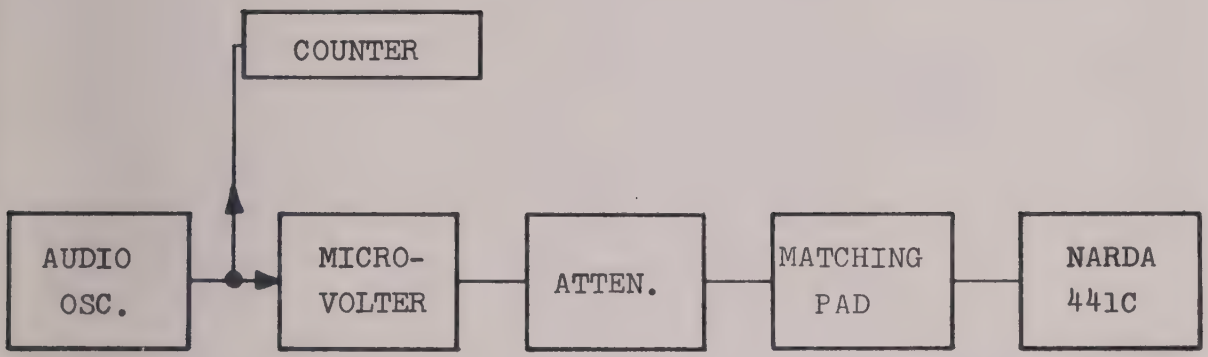
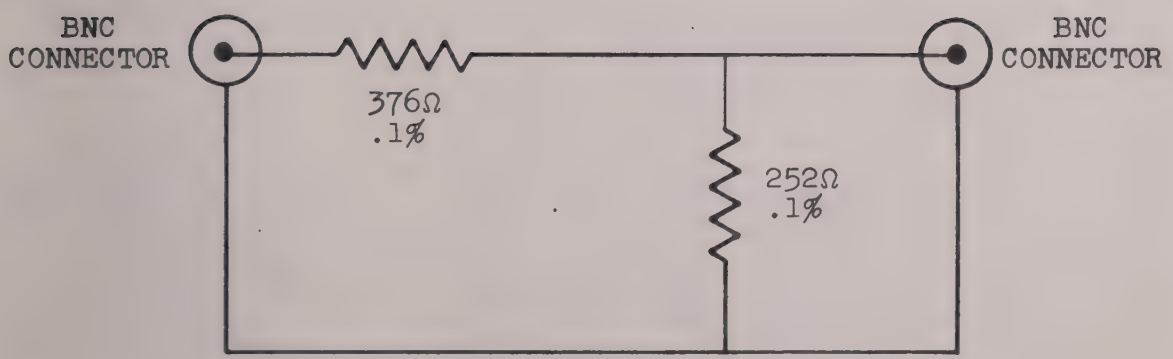


FIG. 7



IMPEDANCE MATCHING PAD

FIG. 8

PARTS LIST (Cont'd.)

Symbol	Description (NARDA Part No.)
J1	Connector - BNC per UG 1094/U (MS 35179)
J2	Binding Post - Dual Assembly H.H. Smith Part No. 269RB
J3	Jack - Switchcraft Part No. 12B
L1	Inductor 441C-313
L2	Inductor 441C-312
M1	Meter 441C-101
441C - 317	Board Mounting Variable Resistor
441C - 322	Potentiometer & Capacitor Assembly
P1	Line Cord Belden Part No. KH 4547
P2	Receptacle - Male Tower Mfg. Corp. Part No. H-1061 1G
Q1 thru Q11	Transistor 2N508A
Q12	Transistor 2N1183
R1	Resistor, 6630 ohms, 1/8 W ± ½% Dale Type DCF
R2, R13, R17	Resistor, 22K, ½ W, ± 5% Allen Bradley EB2235
R3	Resistor, 34.4K, 1/8 W ± ½% Dale Type DCF
R4, R32, R50, R61, R66, R67	Resistor, 1000 ohms, ½ W, ± 5% Allen Bradley EB1025
R5, R20, R31, R41	Resistor, 470 ohms, ½ W, ± 5% Allen Bradley EB4715
R6	Resistor, 18.7 ohms, 1/8 W, ± 1% Dale Type DCF
R7, R29	Resistor, 150 ohms, ½ W, ± 5% Allen Bradley EB1515

PARTS LIST (Cont'd.)

Symbol	Description (NARDA Part No.)
R8, R35	Resistor, 5100 ohms, ½ W, ± 5% Allen Bradley EB5125
R9	Resistor, 10K ohms, ½ W, ± 5% Allen Bradley EB1035
R10	Resistor, 330 ohms, ½ W, ± 5% Allen Bradley EB3315
R11	Resistor, 6800 ohms, ½ W, ± 5% Allen Bradley EB6825
R12	Resistor, Variable Wire Wound IRC #110-100
R14,	Resistor, Variable Wire Wound, IRC #110-5600
R15, R18, R48, R60, R72, R73	Resistor, 100 ohms, ½ W, ± 5% Allen Bradley EB1015
R16, R63	Resistor, 1200 ohms, ½ W, ± 5% Allen Bradley EB4715
R19	Resistor, 910 ohms, ½ W, ± 5% Allen Bradley EB9115
R21	Resistor, 3900 ohms, ½ W, ± 5% Allen Bradley EB3925
R22	Resistor, 680 ohms, ½ W ± 5% Allen Bradley EB6815
R23, R62, R77	Resistor, 100K ohms, ½ W, ± 5% Allen Bradley EB1045
R24	Resistor, 39K ohms, ½ W, ± 5% Allen Bradley EB3935
R25	Resistor, 3410 ohoms, 1/8 W, ± ½% Dale Type DCF
R26, R27	Resistor, 20K ohms, ½ W, ± 5% Allen Bradley EB2035
R28, R46	Resistor, 3000 ohms, ½ W ± 5% Allen Bradley EB3025

PARTS LIST (Cont'd.)

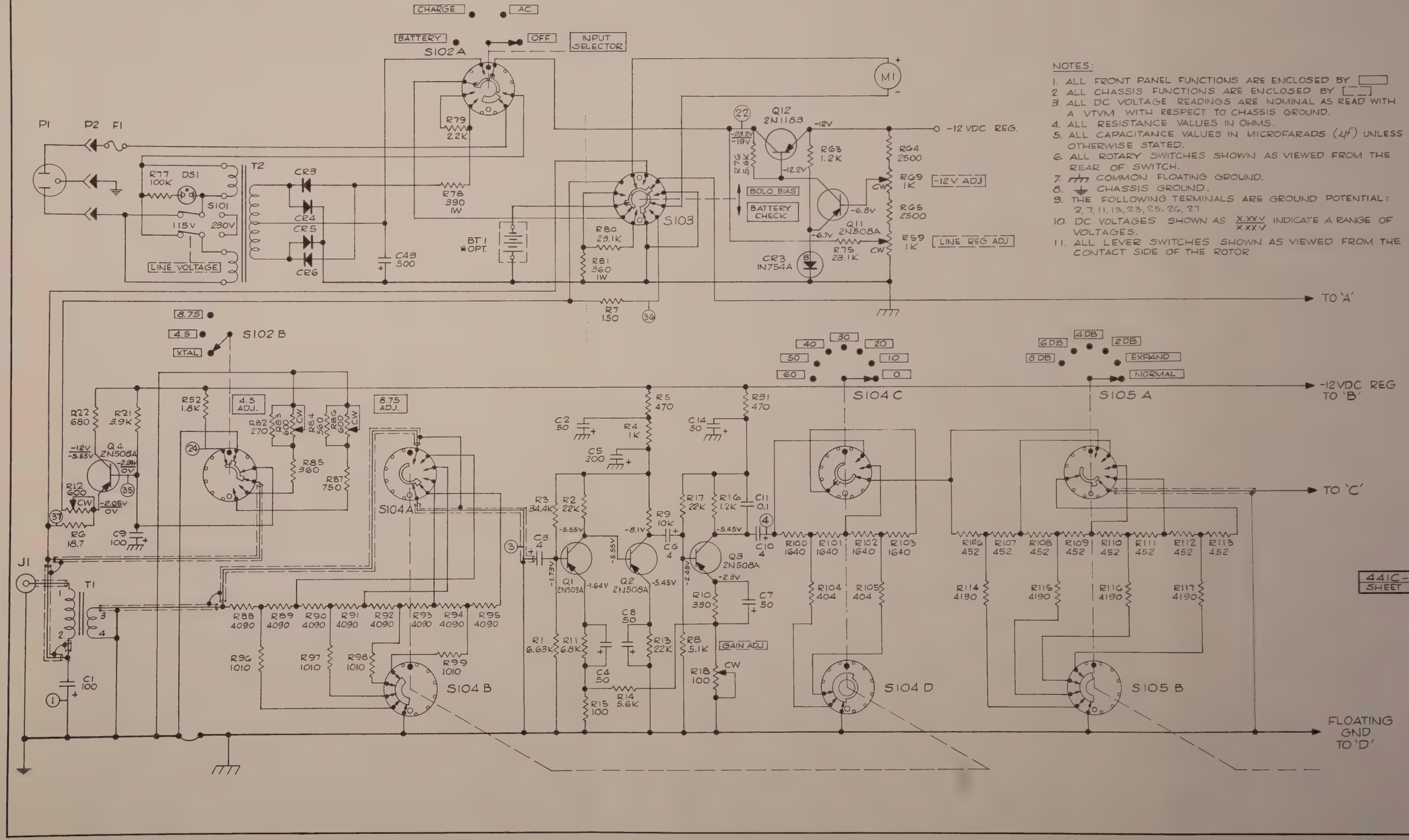
Symbol	Description (NARDA Part No.)
R30	Resistor, 15 ohms, 1/8 W, ± ½% Dale Type DCF
R33, R42, R49	Resistor, 200 ohms, ½ W, ± 5% Allen Bradley EB2015
R34	Resistor, 180 ohms, ½ W, ± 5% Allen Bradley EB1315
R36	Resistor, 13K ohms, ½ W, ± 5% Allen Bradley EB1335
R37	Resistor, 51K ohms, ½ W, ± 5% Allen Bradley EB5135
R38	Resistor, 11K ohms, 1/8 W, ± ½% Dale Type DCF
R39, R54, R56	Resistor, 2000 ohms, ½ W, ± 5% Allen Bradley EB2025
R40, R45, R76	Resistor, 5600 ohms, ½ W, ± 5% Allen Bradley EB5625
R43, R44	Resistor, 82 ohms, ½ W, ± 5% Allen Bradley EB8205
R47	Resistor, 2400 ohms, ½ W, ± 5% Allen Bradley EB2425
R51	Resistor, 9100 ohms, ½ W, ± 5% Allen Bradley EB9125
R52	Resistor, 1800 ohms, ½ W, ± 5% Allen Bradley EB1825
R53	Resistor, 4700 ohms, ½ W, ± 5% Allen Bradley EB4725
R55	Resistor, 8200 ohms, ½ W, ± 5% Allen Bradley EB8225
R57, R58	Resistor, 47 ohms, ½ W, ± 5% Allen Bradley EB4075
R59, R69	Resistor, Variable Wire Wound, IRC #110-1000

PARTS LIST (Cont'd.)

Symbol	Description (NARDA Part No.)
R64, R65	Resistor, 2500 ohms, 1 W, ± 3% Dale Type RS-1A
R68	Resistor, 6310 ohms, 1/8 W, ± 1% Dale Type DCF
R70	Resistor, 10 ohms, ½ W, ± 5% Allen Bradley EB1005
R71	Resistor, 13 ohms, ½ W, ± 5% Allen Bradley EB1305
R74, R83, R86	Resistor, Variable Wire Wound, IRC #110-600
R75, R80	Resistor, 23.1K ohms, 1/8 W, ± ½% Dale Type DCF
R78	Resistor, 390 ohms, 1 W, ± 5% Allen Bradley GB3915
R79	Resistor, 2.2K ohms, ½ W, ± 5% Allen Bradley EB2235
R81, R85	Resistor, 360 ohms, ½ W, ± 5% Allen Bradley EB3615
R82	Resistor, 270 ohms, ½ W, ± 5% Allen Bradley EB2715
R84	Resistor, 560 ohms, ½ W, ± 5% Allen Bradley EB5615
R85	Resistor, 360 ohms, ½ W, ± 5% Allen Bradley EB3615
R87	Resistor, 750 ohms, ½ W, ± 5% Allen Bradley EB7515
R88 through R95	Resistor, 4090 ohms, 1/8 W, ± ½% Dale Type DCF
R96 through R99	Resistor, 1010 ohms, 1/8 W, ± ½% Dale Type DCF
R100 through R103	Resistor, 1640 ohms, 1/8 W, ± ½% Dale Type DCF

PARTS LIST (Cont'd.)

Symbol	Description (NARDA Part No.)
R104, R105	Resistor, 404 ohms, 1/8 W, ± ½% Dale Type DCF
R106 through R113	Resistor, 452 ohms, 1/8 W, ± ½% Dale Type DCF
R114 through R117	Resistor, 4190 ohms, 1/8 W, ± ½% Dale Type DCF
R119, R120	Dual Concentric Potentiometer
R121, R122	Resistor, 1560 ohms, 1/8 W, ± ½% Dale Type DCF
R123	Resistor, 2100 ohms, 1/8 W, ± ½% Dale Type DCF
S101	Slide Switch No. 4633
S102	Switch 441C-211
S103	Switch Lever 441C-212
S104	Switch 441C-210
S105	Switch 441C-209
S106	Slide Switch 441C-310
T1	Input Transformer Assembly 441C-222
T2	Power Transformer Assembly 441C-311


CHARGE
AC
BATTERY
OFF
INPUT SELECTOR
S102A
P1
P2
F1
R77 100K
DS1
T2
CR3
CR4
CR5
CR6
S101
115V
230V
LINE VOLTAGE
R79 2.2K
R78 390 1W
C43 500
BT1 *OPT.
R80 23.1K
R81 360 1W
S103
R7 150
30
M1
Q12 2N1183
22
-23.2V
-19V
R76 R5
-12V
-12.2V
RG3 1.2K
RG4 2500
RG9 1K
-12V ADJ
CW
BOLO BIAS
BATTERY CHECK
-6.8V
RG5 2500
Q11 2N508A
-6.7V
R75 23.1K
R59 1K
LINE REG ADJ
CR3 IN754A
-12 VDC REG.
TO 'A'
NOTES:
1. ALL FRONT PANEL FUNCTIONS ARE ENCLOSED BY [ ]
2. ALL CHASSIS FUNCTIONS ARE ENCLOSED BY [_]
3. ALL DC VOLTAGE READINGS ARE NOMINAL AS READ WITH A VTVM WITH RESPECT TO CHASSIS GROUND.
4. ALL RESISTANCE VALUES IN OHMS.
5. ALL CAPACITANCE VALUES IN MICROFARADS (μf) UNLESS OTHERWISE STATED.
6. ALL ROTARY SWITCHES SHOWN AS VIEWED FROM THE REAR OF SWITCH.
7. COMMON FLOATING GROUND.
8. CHASSIS GROUND.
9. THE FOLLOWING TERMINALS ARE GROUND POTENTIAL: 2, 7, 11, 13, 23, 25, 26, 27
10. DC VOLTAGES SHOWN AS X.XXV / XXXV INDICATE A RANGE OF VOLTAGES.
11. ALL LEVER SWITCHES SHOWN AS VIEWED FROM THE CONTACT SIDE OF THE ROTOR
8.75
4.5
XTAL
S102 B
R22 680
R21 3.9K
-12V
-5.65V
Q4 2N508A
-2.24V
0V
R12 600
CW
-2.05V
0V
35
37
RG 18.7
C9 100
R52 1.8K
4.5 ADJ.
24
R82 270
R83 600
R84 560
R85 360
R86 600
R87 750
8.75 ADJ.
S104A
R88 4090
R89 4090
R90 4090
R91 4090
R92 4090
R93 4090
R94 4090
R95 4090
R96 1010
R97 1010
R98 1010
R99 1010
S104 B
J1
T1
C1 100
R5 470
C2 50
R4 1K
C5 200
R31 470
C14 50
R3 34.4K
R2 22K
-5.55V
-8.1V
R9 10K
C3 4
C6 4
R17 22K
R16 1.2K
C11 0.1
-5.45V
C10 4
Q1 2N503A
-1.64V
Q2 2N508A
-5.45V
Q3 2N508A
-2.48V
-2.3V
C7 50
C8 50
R1 6.63K
R11 6.8K
R13 22K
R8 5.1K
GAIN ADJ
R18 100
CW
C4 50
R14 5.6K
R15 100
40
30
20
50
10
60
0
S104 C
S104 D
6DB
4DB
2DB
8DB
EXPAND
NORMAL
S105 A
S105 B
-12VDC REG TO 'B'
TO 'C'
R100 1640
R101 1640
R102 1640
R103 1640
R104 404
R105 404
R106 452
R107 452
R108 452
R109 452
R110 452
R111 452
R112 452
R113 452
R114 4190
R115 4190
R116 4190
R117 4190
FLOATING GND TO 'D'
441C-107
SHEET 1 OF 2
H

BANDWIDTH CONTROL
FREQUENCY CONTROL
R118 250K
R34 180
R38 11K
L2
C23 2500pf
C44 1100-1600pf
C24 240-1100 pf
C18 4
-11.0V
-6.2V
-6.0V
Q6 2N508A
R25 3.41K
R29 150
R30 15K
R28 3K
C19 50
R33 200
R42 200
C21 50
C28 50
R24 39K
R27 20K
C13 4
R26 20K
C15 0.1
C16 0.1
C17 0.1
R20 470
C12 50
-11.3V
Q5 2N1508A
-6.9V
-6.75V
R32 1K
FINE GAIN
R119 1.5K
R120 10K
COARSE GAIN
R19 910
R23 100K
R35 5.1K
R36 13K
C25 4
-2.19V
R49 200
R41 470
C27 50
C32 50
C22 50
R46 3K
R37 51K
R40 5.6K
-5.45V
-8.2V
Q7 2N508A
Q8 2N508A
-2.05V
-5.3V
R44 82
R43 82
C20 50
R39 2K
C26 50
R45 5.6K
R50 1K
R68 6.31K
2 DB EXPAND ADJ
R74 600
C29 4
S105C
0 DB NORM EXPD ADJ
R73 100
R121 1560
R122 1560
R123 2100
R72 100
S105D
C30 4
R58 47
C35 100
R48 100
R57 47
C34 100
C31 50
R55 8.2K
L1
R51 9.1K
R47 2.4K
-7.4V
-7.35V
C33 4
-3.7V
-1.88V
-1.69
Q9 2N508A
Q10 2N508A
R53 4.7K
R54 2K
R56 2K
C36 50
R60 100
C41 100
C37 50
CR2 IN34A
CR1 IN34A
C39 50
C40 50
R67 1K
RGG 1K
J3 RECORDER
R61 1K
R71 18
R70 10
S106
SLOW
FAST
C42 500
RG2 100K
C38 50
J2 AC OUTPUT

441C-107
SHEET 2 OF 2
H